

GROUP.	SPECIES.	SIZE AND APPEARANCE.
SCARABÆIDÆ.	<i>Onitis albicis.</i>	Medium ; brown elytra and legs, iridescent green thorax and head.
	<i>Onthophagus gazella.</i>	Smallish ; similar colouring to above.
	<i>Gymnopleurus smaragdinus.</i>	Small ; iridescent green, blue, or red.
	<i>Oniticellus militaris.</i>	Small ; probably when fresh iridescent dark-green with orange markings.
HETEROMERA.	<i>Praogenia festiva.</i>	Medium ; almost black with purplish iridescent reflections on elytra, bluish on thorax.
CARABIDÆ.	<i>Anthia thoracica.</i>	Large ; black, white spot on thorax and white margin to elytra. Huge mandibles.
	„ <i>massilicata</i> (only eaten when offered piecemeal).	Large ; black with pale margin to elytra. Huge mandibles.
LONGICORNIA.	<i>Ceropopsis fallax.</i>	Large ; black, yellow-banded, Cantharid type.

22. THE CHIEF CONSPICUOUS SPECIALLY-DEFENDED GROUPS IN THE COLEOPTERA INFERRED FROM G. A. K. MARSHALL'S EXPERIMENTS. A COMPARISON BETWEEN COLEOPTERA AND LEPIDOPTERA IN THIS RESPECT. (E. B. P.)

It is of great interest to attempt to conclude from the results of the experiments on the palatability of conspicuous Coleoptera contained in this memoir, and from previously recorded observations and experiments on the same order of insects, what are the chief specially defended groups which may be considered to stand in the same position towards their allies as the *Ithomiinæ*, *Danainæ*, *Heliconinæ* and *Acravinæ* do to the rest of the Rhopalocera, and the *Agaristidæ*, *Syntomidæ*, *Zygænidæ*, etc., do to the rest of the Heterocera.

The chief memoirs upon which the conclusions stated below have been based are published in the Transactions of the Entomological Society of London. They are the papers by Mr. C. J. Gahan (1891, p. 367), by Mr. H. Donisthorpe (1901, p. 345), and the Presidential Address of Canon W. W. Fowler, Jan. 15, 1902 (Proc. 1901, p. xxxiii). I have also had the opportunity of reading the manuscript of an important paper by Mr. R. Shelford on mimicry in Bornean insects, now being published by the Zoological

Society of London, and of arranging an abstract which is printed in the Report of the British Association at Bradford, 1900, p. 795.

But, above all, I wish to express my thanks to Mr. C. J. Gahan and Mr. G. A. K. Marshall for their kind advice and assistance in the attempt to arrive at sound conclusions.

The groups about which there seems to be no doubt at all—conspicuous, constantly refused by insect-eaters, and liable to be mimicked by other Coleoptera—are the following:—

1. EROTYLIDÆ. Very apt to enter into conspicuous combinations which are doubtless synaposematic with other beetles.

2. COCCINELLIDÆ. Greatly mimicked by other beetles and insects of other orders. Very commonly form synaposematic assemblages (see p. 520).

3. MALACODERMIDÆ, including the *Lycinæ*, *Lampyrinæ*, and *Telephorinæ*. Greatly mimicked by beetles of other families, and also by insects of other Orders (see pp. 515–518).

4. MELYRIDÆ. Some of the species convergent towards *Lycinæ* and *Telephorinæ*; others characterized by the possession of thoracic glands, which are exerted when the insect is irritated.

5. CANTHARIDÆ. Undoubtedly a distasteful group with conspicuous warning coloration. Some of the species are synaposematic with other beetles, and with Aculeate Hymenoptera (see pp. 516–518 and 525–527), while others afford models for mimicry and synaposematic approach (pp. 518, 519).

6. CHRYSOMELIDÆ. The sub-families, *Galericinæ* and *Hispinæ* are especially largely mimicked by other beetles, and fall into synaposematic combinations. The *Chrysomelinæ*, *Eumolpinæ*, etc., also enter into combinations which are doubtless Müllerian (synaposematic). The *Megalopinæ*, however, may be mimetic (pseudaposematic) rather than synaposematic.

Concerning the last-named family, Mr. Gahan writes to me, March 3, 1902:—

“In reference to my previous paper on *Diabrotica* [Trans. Ent. Soc. Lond., 1891, p. 367], there are a few facts since published in a paper by F. M. Webster ‘On the probable origin, development, and diffusion of North American species of *Diabrotica*.’

“ ‘The fact that several species of this genus are literally swarming over large areas of country, and their habits are such as to expose them almost continually during the adult stage to attacks of birds, while in all of the investigations of the food of birds they rarely appear, has raised the question of their being inedible.’

“ Webster gives also a quotation from Bates’ ‘Naturalist on River Amazon,’ which I had overlooked:—

“ ‘The Eumolpidæ and Galerucidæ were much more numerous than the Chlamydes and Lamprosomas, although being also leaf-eaters, and having neither the disguised appearance of the one nor the hard integuments of the other; but many of them secrete a foul liquor when handled, which may perhaps serve the same purpose of passive defence.’ ”

There are two other groups which may eventually be placed beside the six families named above.

ENDOMYCHIDÆ. Mr. Shelford’s experiments show that several of the Bornean species are most distasteful. They are abundant and extremely conspicuous: they form synaposematic groups, especially with the *Erotylidæ*, and there is one beautiful example of mimetic resemblance to an Endomychid model by a Bornean Longicorn. The style of colouring in the family suggests that it contains Müllerian groups (see also p. 522).

PYROCHROIDÆ. The colouring and habits suggest that these Coleoptera are highly distasteful; they may even belong to the first rank in this respect.

We now pass to a Coleopterous family which may with more probability be placed beside the *Hypsidæ* or *Chulcosiinaæ*, undoubtedly distasteful groups of moths which nevertheless are exceedingly apt to display Müllerian resemblances to other presumably still more strongly-protected Lepidoptera. In such synaposematic combinations they appear perhaps invariably to take the patterns and colours of others, rather than impress the stamp of their own likeness on the assemblage.

CLERIDÆ. These beetles are, like the above-named moths, most apt to take on the appearance of still more distasteful allies, such as the *Lycinaæ*, the *Cantharidæ*, the *Galerucinaæ*, and, in the genus *Allochotes*, the *Coccinellidæ*. They are great mimics of *Mutillidæ*, and less commonly of ants. Mr. Shelford has come across one beautiful example of the mimicry of common Bornean Clerids of the genus

Lemidia, by a Longicorn of the genus *Daphisia*. The common mimicry of *Mutillidæ* may be due to an original body-form, size, and colouring, which rendered the resemblance to such models peculiarly easy and rapid of attainment by selective means. *Cleridæ* also occasionally possess warning colours of their own. Examples are found in the genus *Lemidia* mentioned above, and in an abundant, bright-red, strongly-smelling South African species of a genus which is probably new. The latter was rejected by insect-eating animals (see p. 344).

We now come to four groups which the experiments here recorded show to be at any rate partially distasteful. They are often very conspicuous, sometimes from an aposematic colouring peculiar to themselves, sometimes from their sluggish movements and size, and the manner in which they expose themselves or move freely in the open. They are, however, not as a rule mimicked by other beetles, and they do not largely enter into synaposematic association with the most distasteful Coleoptera.

SCARABÆIDÆ. The diurnal South African species are all conspicuous, and freely expose themselves. Their colours, black, green, or coppery, are all conspicuous against the ground on which they are always found. The largest South African species (*Scarabæus femoralis*) adopts a warning attitude when it is disturbed. Many of the species were evidently distasteful to insect-eaters. It is possible that their special defence is due to the nature of their food.

CETONIDÆ. The majority of South African species, including all the larger species, are conspicuous on flowers or exuding gum. They freely take wing in sunshine, but are quite sluggish in cloudy weather. Their colours vary greatly, but very conspicuous and contrasted tints are often present. Many of the species were found to be unpalatable.

TENEBRIONIDÆ. Mostly dull browns and blacks, generally diurnal, terrestrial, and slow-moving. Several species proved to be distasteful.

LAGRIDÆ. The South African species are often iridescent green or purplish, many brown or black. They are abundant and very sluggish; they freely expose themselves in conspicuous positions on leaves, and have a strong smell. Although but few experiments were made, it is probable that the whole group is distasteful.

The case of the Longicornia is peculiarly interesting.

They may be considered as parallel to the *Nymphalinae* among Rhopalocera. In both we have a great preponderance of species with cryptic habits and colouring, while genera mimetic of the most distasteful groups of their respective Orders are also common. In some of these examples the mimicry is almost certainly Müllerian, as in the case of *Neptis* and *Limnitis* among the *Nymphalinae* and *Cymatura* and *Ceroplesis* among Longicorns. Furthermore, the *Clytinae* and *Cullichrominae* have been shown by Mr. Shelford to be mimicked in Borneo on a large scale by other Longicorns, although the former tend strongly to mimic Aculeates in nearly all parts of the world. Similarly, there is good reason for thinking that the genera *Neptis* and *Limnitis*, which may be mimetic, are also themselves mimicked by other *Nymphalinae*, etc.

There remain the remarkable cases of the *Cicindelidae*, *Carabidae*, and *Curculionidae*, which are probably without any strict analogy in the Lepidoptera. The two former require special mention, the last-named are treated separately on pp. 522-525.

CICINDELIDÆ. These Coleoptera supply models for mimicry by a Locustid in Borneo, and Mr. Shelford also considers that one of them is mimicked by a fly. They are also known to be mimicked by Longicorns. Many South African *Cicindelidae* are convergent towards, or mimetic of, *Carabidae*, especially those of the latter which are themselves convergent towards *Mutillidae* (see pp. 511-515). Some of the species have a peculiar scent. On the other hand, their swift movements and retiring habits are inconsistent with a high form of special protection.

CARABIDÆ. Mimicked in Borneo by a Locustid. Probably more strongly defended by the possession of anal glands than are the *Cicindelidae*, and in the combinations between the two families it is seen that the latter have approached the former, rather than *vice versa*. Certain groups of *Carabidae* form pseud- or synaposematic combinations with the *Galerucinae* and also with the *Mutillidae*. The South African smaller and moderate-sized diurnal species have habits very similar to the *Cicindelidae*, but are not so swift. They commonly possess directive marks indicating the specially-protected anal region. The largest South African species (*Anthia*) have a very large charge of the defensive secretion and extremely powerful mandibles. They freely expose them-

selves, and are most conspicuous, often possessing a highly-characteristic warning pattern. They adopt special warning attitudes, and do not run away when they are attacked (see p. 510).

These two families may be perhaps compared to the powerful group of the hawks, which are mimicked by the feeble cuckoos, and yet, when attacked, are themselves swift in flight, but can render a good account of themselves when active defence becomes necessary.

23. EXPERIMENTAL EVIDENCE OF THE VALUE OF THE TERRIFYING MARKINGS IN *Chærocampa* LARVÆ.
(G. A. K. M.)

Salisbury, April 16, 1899.—I offered baboons a full-grown larva (about seven inches long) of *Chærocampa osiris*. The larva is remarkably snake-like, the general colouring somewhat recalling that of the common puff-adder (*Bitis arietans*). The female baboon ran forward expecting a tit-bit, but when she saw what I had brought she flicked it out of my hand on to the ground, at the same time jumping back suspiciously; she then approached it very cautiously, and after peering carefully at it from the distance of about a foot, she withdrew in alarm, being clearly much impressed by the large blue eye-like markings. The male baboon, which has a much more nervous temperament, had meanwhile remained at a distance surveying the proceedings, so I picked up the caterpillar and brought it towards them, but they would not let me approach, and kept running away round and round their pole, so I threw the insect at them. Their fright was ludicrous to see; with loud cries they jumped aside and clambered up the pole as fast as they could go, into their box, where they sat peering over the edge watching the uncanny object below. After a while the female seemed inclined to descend to investigate matters again, but owing to the manner in which they had entangled their ropes she could not descend without the male, and he very emphatically refused to move. On concealing the larva I managed to coax them down again, and then seizing the rope to which the male was tied, I drew him slowly towards me holding up the larva in the other hand; he simply screamed in abject terror, so I let him go, and they retired to their box. The whole performance was a most remarkable demonstration of the high value of the terrifying colours in these larvæ.